UNIVERSITY OF CALIFORNIA
UCMERCED

Syllabus for ME-211: Nonlinear Controls

Fall 2018
Instructor: YangQuan Chen

Designation:

Upper division graduate course

Catalog Description:

Phase plane and singularities. Methods for nonlinear analysis. Lyapunov stability theory. Passivity. Lyapunov control design. Topics of nonlinear controls including feedback linearization, sliding control and back stepping design. Adaption algorithms and system identification. Discussion of current research topics in nonlinear controls.

Text Books and Other Required Materials:

- Hassan K. Khalil. *Nonlinear Control*. 1/E. Pearson Education 2015. ISBN-10: 0-13-349926-X; ISBN-13: 978-0-13-349926-1

Reference Text Books:

- Dingyu Xue and YangQuan Chen. "*System Simulation Techniques with MATLAB® and Simulink®*". 2013 John Wiley & Sons, Ltd. ISBN: 978-1-118-64792-9. https://mechatronics.ucmerced.edu/simubook2013wiley

Course Objectives/ Student Learning Outcomes:

- Understand distinct features of nonlinear dynamical system vs. linear systems
- Analyze local and global stability concepts and their applications in control design and performance evaluation
- Learn the techniques of feedback linearization and their limitations, apply it to nonlinear control design
- Design variable structure controls and sliding mode control
- Analyze robustness and adaptivity of nonlinear controls
- Study mathematical skills and experimental perception of nonlinear dynamical systems and control
- Study practical application aspects of nonlinear controls

	Relationship to Program Learning Outcomes and Program Requirements: Completion of the course provides advanced control design skills for the completion of masters or doctoral degrees.
Prerequisites by Topic:	Ordinary Differential Equations, Linear Algebra, Linear Controls.

Course Policies:

Academic Dishonesty Statement:	a. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work. b. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action. c. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.
Disability Statement:	Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.
Topics:	Review of ODEs, phase portrait, limit cycle, and nonlinear analysis. Local and global Lyapunov stability theory; application of Lyapunov stability theory to nonlinear control design and performance analysis; passivity concepts; describing function; feedback linearization; sliding mode control; adaptation algorithms; composite controls.
Class/laboratory Schedule:	Lecture MW 9:30-11:20am @ GLCR 132

Midterm/Final Exam Schedule: Take Home Mid-Term Exam at week-10. No Final Exam.

Course Calendar:

Week#	Lecture #	Topic	Textbook Chapter
1	1	Introduction	1
1	2	Two-dimensional systems	2
2	3	Stability of equilibrium points	3
2	4		
3	5		
3	6		
4	7	Time-varying & perturbed systems	4
4	8		
5	9	Passivity	5
5	10	Passivity / Input-output stability	5, 6
6	11	Input-output stability	6
6	12	Stability of feedback Systems	7
7	13		
7	14		
8	15	Special nonlinear forms	8
8	16	State feedback stabilization	9
9	17		
9	18		
10	19	Robust state FB stabilization	10
10	20		
11	21		
11	22	Observers	11
12	23		
12	24	Output feedback stabilization	12
13	25		
13	26		
14	27	Tracking & Regulation	13
14	28		
15	29		
15	30	FISP Presentations	
16	31	FISP Presentations	
16	32	FISP Presentations	

Professional Component: Analysis and control of nonlinear dynamical systems with engineering applications to robotics, aircraft, automobiles and buildings. Experimental perceptions of control implementation.

Assessment/Grading Policy: Letter Grading

Homework (50%)

Take Home Midterm Exam (25%)

Focused Independent Study and Presentation (25%)

Coordinator:

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Office Hours: MW 13:00-14:00 or by appointment @ SE2-273